Fruits of Tomato Cultivars with Low BER Susceptibility Show Higher Antioxidant Capacity under Stress Condition in Root Zone

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Abstract

Tomato is an important fruit bearing vegetable crop in Japan and the world. Tomato fruit is highly affected by a physiological disorder in its distal part, named blossom-end rot (BER). The susceptibility to this disorder is very variable among different cultivars. The reason behind this difference of susceptibility was not well clarified.

Blossom-end rot is widely accepted as a calcium-related physiological disorder. The reason is that it was associated with lower fruit calcium concentrations and the application of calcium solution sprays on tomato fruits helps reducing its appearance. The common admitted mechanism for BER is that calcium deficiency causes cell death by destabilizing cell membranes. However, despite the continuous efforts to determine a critical fruit calcium concentration under which BER is triggered, no consensus was established and BER initiation mechanism remained unclear for decades. Recent studies established that a more localized deficiency of soluble calcium in the apoplast is the main cause for BER, as it leads to unstable membranes without affecting total calcium concentration. These findings helped explaining why no critical fruit calcium concentration was found for BER appearance.

Other author proposed that oxidative stress has also a role to play in the BER appearance mechanism. In fact, BER was found to appear when ROS production is high and scavenging capacity is low in pepper fruits. In tomato fruit, ascorbate is known to be the main fruit antioxidant. Interestingly, the very same conditions that trigger BER appearance are also reported to decrease ascorbate concentrations and

increase ROS levels in tomato fruit. So, we hypothesized that greater resistance to BER might associate with higher ascorbate concentrations.

In our study, we tried to explain the difference of susceptibility between various tomato cultivars by comparing the factors determining their abilities to uptake calcium and also their antioxidant capacities. Four cultivars from European and Japanese origins were used as a model, and were subject to stress condition in the root zone. In our results, Ca^{2+} concentrations did not associate with BER appearance in tomato fruit. Our findings suggest that tomato cultivars with a high resistance to BER have a higher antioxidant capacity in their distal pericarp, presumably represented by ascorbate, prior to and during symptom appearance. These cultivars also have lower $(K^{+}+Mg^{2+})/Ca^{2+}$ ratios in the same tissues during symptom appearance. These ratios are maintained low by having more calcium in the distal pericarp. In the case of European cultivars, higher calcium concentrations under root stress condition, associated well with improved xylem-vascular bundle functionality. In conclusion, we hypothesize that cell nutrient imbalances might be a trigger for cells disintegration after damage by excessive ROS in the tissues affected.